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Abbreviated Workshop Summaries

Lt Col Robert Rizza presented the following summary information from each workshop cochair:

Workshop 1A: How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas

(1) More observations may be better but only if used/assimilated intelligently.

(2) Models need to be robust. They must be able to run at any time, 24/7.

(3) We need a skillful "data assimilation" system.

(4) We must understand true use before an observational network can be designed.

(5) Metadata is critical to making data useful.

Workshop 1B: Understanding the Needs of Urban Communities and Businesses

(1) More collaboration is needed.

(2) We could/should run economic models at the same time as we run meteorological models to clearly understand forecast impacts.

(3) We need to understand how people interpret what meteorologists say.

(4) Both public and private sector forecasters are affected by the knowledge and/or fear of possible law suits over less than perfect forecasts.

Workshop 2A: Measurement Strategies for the Urban Weather and Climate Domains (sensors, data collection, transmission, archiving, etc.)

(1) The strategy for cost-effective collection of measurement data for decision makers should focus on things that can be done now.

(2) A process is needed to determine the amount of data and the number of sensors needed to make decisions that minimize cost and characterize the unique complexity of terrain in every city.

(3) Users are not aware of and therefore are not using emergency decision-making information that is available today. Outreach, education, and training mechanisms are needed.

(4) A delivery system for providing layered GIS information to all public and commercial sectors is needed. Bringing this type of system into operations may require a change in federal policy.

(5) We must define a process on how to design a network on an urban scale and address particular decision-making applications (e.g., define questions for applications and interact with users).

Workshop 2B: Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues

(1) We need improved multi-scale observations in the urban environment with an emphasis on the vertical observation of the Planetary Boundary Layer.

(2) A national database management center that includes self-documenting metadata in standardized formats needs to be established.

(3) To manage within an ecological framework, we need to provide for the integration of all types of data (e.g., social, demographic, and economic).

(4) We need to be able to assimilate remotely sensed surface/building data and aerosol data into the models.

(5) We need to couple atmospheric transport and diffusion model outputs with consequence models addressing health, safety, and other impacts.

(6) We need to develop model verification and validation procedures based on user metrics.

(7) We need to enhance the interface with users. For example, we need to find out what users want, how they operate, and get their feedback during the product development/prototyping process.

Workshop 3A: Communicating Hazardous Weather Risks in the Urban Environment

(1) We need to standardize ways to communicate risk to the public and advise the public on what actions to take (e.g., terms, colors, probability forecasts, and graphics).

(2) Research is needed to determine the terms to use on a national level to communicate (e.g., work with public and social scientists to determine the best solution).

(3) The public is mobile. Therefore we need GIS/GPS-coded messages to advise the public of potential hazards regardless of the public's location.

Workshop 3B: Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, ATD, Space Weather, and Climate Applications

(1) We need to collect, process, and synthesize data from existing field studies.

(2) We need to pull together and extend with additional parameters, urban data sets that are being developed by cities, government agencies, and others to develop, calibrate, and evaluate urban models.

(3) We need to establish standards and guidelines for databases, model output, and performance criteria.

(4) Research and development needs should be prioritized based on user needs.

(5) The transfer from research to operations should be user-based and include collaboration during all phases of the system life-cycle. Users should be included early and often. Recognition of the differences in user communities is needed.

(6) Collaboration needs to include leveraging of planned experiments, a clearinghouse for information, and better communications among user communities.

A summary of the Forum, as well as Lt Col Rizza's remarks, can be found on the OFCM website: www.ofcm.gov.

Urban Meteorology Forum
Workshop 1A Summary

Workshop Name: How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas

Workshop Cochairs: (1) Dr. Stephen Lord, DOC/NOAA/NWS; and (2) Col Mark Weadon, DOD/USAF/Air Force Weather Deputy for Federal Programs - NOAA

Rapporteurs: (1) Mr. Donald Carver, DOT/OFCM; and (2) Lt Col Robert Rizza, DOD/USAF/OFCM

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What are the primary deficiencies in the content of weather observations for urban areas in relation to modeling and operational needs?

(2) What new sensors or other technologies are available or emerging that could improve the content of weather observations for urban areas?

(3) What kind(s) of R&D should receive emphasis to meet unaddressed deficiencies in weather observations for urban areas?

(4) Are new communication technologies sufficiently robust to accommodate current and future observation content, processing and dissemination for operational needs?

Synopsis

Opening Remarks

The workshop opened with a joint presentation from DTRA and AFWA. The presentation described DTRA and AFWA's efforts to support the summer Olympics. Data from standard WMO stations and the University of Athens mesonet was leveraged. Hazard Prediction and Assessment Capability was utilized via reach-back. The briefing served to stimulate discussion of the four guiding questions.

Group Discussion

A wide-ranging discussion on "How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas" resulted in the following major findings or themes:

(1) There is a need for standardized urban meteorology database.

(2) Detailed data on urban area/land use is an essential tool for decision makers.

(3) Comprehensive data quality control will be needed to address issues in the urban environment.

(4) The issue of model bias – weak or strong forcing function should be explored.

(5) An intelligent design of observational system/network is needed.

(6) A high-resolution turbulence parameterization is critical.

(7) Optical sensing using LIDAR technology should be considered as being applicable to the urban environment.

(8) A test bed strategy should be utilized to evaluate options.

(9) Defining/gathering metadata and archiving considerations is critical to addressing challenges in the urban environment.

(10) Sensing strategies (e.g., the DTRA/AFWA presentation about Athens Olympic support) can serve as "lessons learned."

(11) A national high resolution precipitation mosaic is a priority.

(12) Optimum sensor positioning: a ring of profilers around urban areas with an array of rooftop sensors is an essential tool for addressing environmental challenges in the urban environment.

(13) Resolution of data should not overwhelm the capacity of model to parameterize.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) More observations may be better but only if used/assimilated intelligently.

(2) Models need to be robust. They must be able to run at any time (24/7), under all atmospheric conditions.

(3) There is a need for a "data assimilation" system and an accurate model for microscale applications to address such areas as:

(a) PBL physics & turbulence

(b) Accurate precipitation forecasts

(4) Understanding applications before observational network can be designed is a must.

(5) Metadata is critical to making data useful

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Investigate Oklahoma City mesonet data for use in urban meteorology sensing studies.

(2) Investigate any existing siting standards for urban observing systems.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Establish urban observation siting standards.

(2) Establish test beds to optimize sensor placement/assimilation.

The **long-term action items/issues** (those which can be addressed in 4 – 10 years) included:

(1) Support the New York City urban meteorology sensing model/system development.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 1B Summary

Workshop Name: Understanding the Needs of Urban Communities and Businesses

Workshop Cochairs: (1) Mr. Floyd Hauth, OFCM/STC; and (2) Dr. Betty Hearn Morrow, Consultant and Professor Emeritus of Sociology, Florida International University

Rapporteurs: (1) Mr. Frank Estis, OFCM/STC; and (2) Mr. Rickey Petty, DOE/Climate Change Research Division

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What do forecasters need to know about today's urban communities?

(2) How does the changing nature of urban communities affect their requirements for meteorological information?

(3) What information will best help urban businesses prepare for and respond to hazards in the five focus areas?

(4) What are the major deficiencies in meteorological information (including communication and interpretation of the information)? Which should receive priority in R&D or technology transfer?

(5) Are additional education, training, and outreach activities needed?

Opening Remarks

The workshop cochairs provided opening presentations to set the stage for the group discussion. Dr. Betty Hearn Morrow offered the following thoughts:

(1) Cities are:

(a) Where most people choose to live.
(b) Where some of the most vulnerable populations dwell.
(c) Vital to the national and world economy.

(2) Urban dwellers need to:

(a) Understand hazards.
(b) Be warned and know how to respond.
(c) Be safe at home and at work.
(d) Recover quickly.

(3) The responsibilities of the meteorological community include:

(a) Practicing good science.
(b) Working together to improve forecasts.
(c) Interpreting weather and climate information for urban managers and the general public.
(d) Communicating uncertainties and possible outcomes of low probability, high impact events.
(e) Helping the public make responsible choices.

(4) The deficiencies in meteorological information include:

(a) Inadequate knowledge of urban environment including populations.
(b) Problems with communicating uncertainty and risk.
(c) Limited coordination of efforts within the discipline.

(5) Obstacles and challenges are:

(a) A work culture characterized by:

- Interagency divisions, competitions.
- Private-public dichotomy.
- Introspection.

(b) Language challenges can be addressed by:

- Simplifying the message which is provided.
- Testing delivery and response.

(c) Outcome measurements which should be converted to societal impacts.

(6) More social science involvement which should include such activities as:

(a) Identifying stakeholder needs (e.g., stratified sample surveys of emergency managers and the general public).
(b) Testing messages and delivery systems (e.g., focus groups, simulations).
(c) Conducting post-event assessments (e.g., fieldwork, surveys).
(d) Understanding work culture (e.g., ethnographic studies of work environment).

Mr. Floyd Hauth provided the following opening remarks:

(1) Urban hazard mitigation factors include:

(a) Population density.
(b) Urban land use and building types.
(c) Transportation systems.
(d) Housing vs. urban poor.
(e) Storage of hazardous materials.
(f) Security risks posed by social issues.

(2) Hazard identification and vulnerability assessment encompass:

(a) Historical information.
(b) Shared experiences.
(c) An inventory of hazards.
(d) Impacts/consequences of hazards.
(e) Types of natural hazard information which includes:

- Incidence of hazard risks in the area of interest.
- Incidence of hazard risks in market areas and commercialization routes.
- Vulnerability of the supply and/or cost of production inputs (e.g., raw materials, equipment, energy resources) to natural hazard events.
- Vulnerability of the business output prices to natural hazard events.
- Vulnerability of physical structures and production processes to natural hazard events.
- Existence of current and/or proposed legislation that establishes guidelines for natural hazard risk mitigation in community or business design.
- Effectiveness and cost of alternative natural hazard mitigation measures.

(3) Strategic planning should incorporate:

(a) Building on known strengths and past successes.
(b) Information gathering.
(c) Communication.
(d) Partnerships and collaboration.
(e) Budgetary opportunities.
(f) Ownership.

(4) The components of an integrated methodology are:

(a) Performance criteria.
(b) Modeling economic system response.
(c) Evaluating economic aspects of mitigation strategies.

(5) Catalysts for urban strategy are (but not limited to):

(a) Public policies.
(b) Community action.
(c) Private sector commitment.
(d) Accountable local government
(e) Supportive national government

(6) The next steps for moving forward include:

(a) Gathering data.
(b) Identifying hazards.
(c) Assessing vulnerabilities.
(d) Categorizing and develop approaches to risks.
(e) Determining needs and priorities.
(f) Supporting multi-discipline research and applications.

Group Discussion

A wide-ranging discussion on "Understanding the Needs of Urban Communities and Businesses" resulted in the following major findings or themes:

(1) Most users of weather information now live in urban areas.

(2) Urban dwellers are more likely to be new to the area and to be renters.

(3) One in five households is headed by someone who speaks a foreign language.

(4) Most households now have computers and approximately 42% have internet connections.

(5) One in four businesses that close after a disaster never reopens.

(6) Weather messages need to be tested to see if they are understood.

(7) Ways to get people back to their homes more quickly after a disaster are needed. In some cases people don't evacuate due to fear of long-term separation from personal belongings and possible looting.

(8) A study of the uses of and an evaluation of the 5-day forecast including unexpected consequences (such as staging and storing emergency supplies, extra stress, etc) needs to be completed.

(9) The possible role of fear of law suits due to the weather forecasts and warnings issued by both public and private sectors may influence the work that these sectors perform.

(10) Identifying the types of natural hazard information needed by various sectors and users is needed.

(11) Broadcast media often feel "out of the loop" with NWS during events.

(12) There is a need for more collaboration with other disciplines such as social sciences as well as intra-discipline collaboration.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Urban users of weather information are very diverse.

(2) Today's forecast messages need to be tailored to diverse urban audiences.

(3) There is a need to better understand how different population groups interpret and use meteorological messages.

(4) More collaboration is needed.

(5) Economic models could/should be run at the same time as meteorological models are run to clearly understand forecast impacts.

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Involve more social science in such activities as: identifying stakeholder needs (stratified sample surveys of managers and general public); testing messages and delivery systems (focus groups, simulations); post-event assessments (fieldwork, surveys); and understanding work culture (ethnographic studies of work environment).

(2) Investigate possible changes to the use of the terms "watch" and "warning" to develop an improved public warning notification system.

(3) Evaluate the effects of 5-day forecasts.

(4) Investigate how broadcast meteorologists can have more interaction with NWS and participate in key forecast conference calls dealing with potential disastrous or large-scale weather events which will have a significant impact on the population.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Fund social science research for such activities as:

(a) Identifying urban stakeholder needs (stratified sample surveys of managers and general public).
(b) Testing messages and delivery systems (focus groups, simulations).
(c) Post-event assessments (fieldwork, surveys).
(d) Economic implications of forecasts.
(e) Understanding meteorological work culture (ethnographic studies of work environment).

(2) Investigate ways to share weather forecasts concerning potential disasters with the public media sooner, and (using the latest forecast data) allow interactions with NWS and government agencies (e.g., emergency managers) during the coordination of required actions.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by workshop participants.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 2A Summary

Workshop Name: Measurement Strategies for the Urban Weather and Climate Domains (sensors, data collection, transmission, archiving, etc.)

Workshop Cochairs: (1) Mr. Richard Fry, DOD/DTRA; and Dr. Sharon LeDuc, DOC/NOAA/NESDIS

Rapporteurs: Mr. Rickey Petty, DOE/Climate Change Result Division; and (2) Mr. Tony Ramirez, OFCM/STC

Guiding Questions

The questions poised below for this workshop were intended as guidance for focusing the workshop discussion.

(1) How should an observing network be designed to meet the requirements for meteorological and climate data in the urban environment? Which measurement tools, procedures, and processes are needed?

(2) What current programs (e.g., observational test beds, space-based systems) are addressing or planning to address observing network requirements?

(3) Which measurement strategies will provide the most efficiencies and best cost/benefit returns for operational decision makers?

(4) What needs are to be addressed across the spectrum of data gathering, collection, assimilation, archival, and dissemination processes?

(5) Are different observing networks needed for weather and climate domains in the near, mid, and far terms?

Synopsis

Opening Remarks

Dr. Leduc and Mr. Fry opened the workshop by reviewing the guiding questions and discussing the focus areas to be addressed during the workshop. Dr. Leduc discussed the initiatives within the meteorological community toward developing and implementing test beds in urban areas. She pointed out that these test beds should not only be deployed within the boundaries of urban areas but should also be placed in areas downwind to measure emissions from cities. She further stated that archived data is a current and growing need in the community.

Mr. Robert Banta, NOAA Environmental Technical Library, provided a short presentation on "Urban Projects." He discussed the use of Lidar in vertical and horizontal measurements by aircraft of airborne ozone. These measurements provide a capability to resolve the airborne distribution of matter in high resolution and provide a means of measurement for model verification. He further stated that data sets exist and are available from modeling experiments which use surface measurements and aircraft measurements with tracers to provide a controlled release of emissions.

Group Discussion

A wide-ranging discussion on "Measurement Strategies for the Urban Weather and Climate Domains" resulted in the following major findings:

(1) In an attack scenario, one of the immediate challenges facing first responders is determining the originating location or source of the agent being emitted. It may be feasible to "run the model in reverse" to serve in this purpose.

(2) Although ground-based Lidar exists, airborne Lidar provides much needed mobility. Ideally, for a given urban environment, an array of ground-based Lidars covering the extent of the urban area would be most useful.

(3) DHS and DTRA have funded a program to improve the diffusion network in New York City. This network uses tracer procedures for test and verification. This network is designed to be a long-term, highly reliable network with the capability of reporting in approximately 15-minute intervals.

(4) The sheer amount of data being generated by urban networks is likely to flood the existing databases and saturate the capability of existing communications infrastructure. The integrated surface observation (which includes ASOS, COOP, and climate reference network observations) increases the need for quality metadata, improved communications, and backup capabilities for both receipt and dissemination. Although bandwidth seems to be keeping up with today's volume, these capacities will also require expansion.

(5) State departments of transportation provide a source of road weather data. These data should be included in urban weather databases. The NOAA/Forecast Systems Laboratory ingests and archives road weather observation data. It is a significant part of its database that can be leveraged for urban applications.

(6) There is a need for separate weather sensors and climate sensors. The current and foreseeable budget climates will drive the need for multipurpose sensors (that can serve both weather and climate applications) rather than separate sensors. There appear to be sufficient similarities between both types of sensors.

(7) Strategies for cost effective measurements of weather parameters to meet the needs of operational decision makers should be based first on initiatives that are immediately affordable and achievable (low-hanging fruit). They should also be based on the

minimum amount of weather data and information needed by decision makers. A process is needed to determine the number of sensors needed at minimum cost, and should be applied to meet the unique complexity of each urban terrain. The specific needs will likely differ between different cities.

(8) First responders have a critical need for awareness of and access to the information and products that are available right now. There is a belief, however, that new technologies, products, and capabilities are not being used by first responders because they are not aware them. This indicates a need for better outreach, education, and training programs for users. To the first responder community, knowledge of and access to new products and support mechanisms is much more important than those in research and development. Rapid prototyping of new support mechanisms will be much more useful than those undergoing long periods of development, implementation, and validation. For information that is currently being used by first responders, improved communications and delivery mechanisms are a continued need.

(9) The first responders are only one part of the broad spectrum of users in the urban environment. Communications between users and providers must improve in order to ensure that the critical needs of the users are being met. The use of available data sources like GIS should be incorporated into the support mechanisms of every city. GIS-based support systems can be layered to meet the differing resolution needs of users. Federal agencies do not have a delivery system for this type of information for all users in the public domain or the commercial sector. A change in federal policy may be needed to allow these communications to be authorized.

(10) With regard to measurement strategies, the need to define a measurement system design process was proposed as the first step. This process should include steps on determining how to address particular applications, listing of each problem, designing implementation plans, and determining overlaps. A recently published U.S. Weather Research Program report outlines urban challenges and offers ideas on the design of networks on an urban scale. A review of this report should be a first step for action groups formed as the result of this forum.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Strategies for the cost effective collection of weather and climate measurement data for decision makers should first focus on things that can be accomplished immediately.

(2) A comprehensive process is needed to determine the amount and type of data needed and the number of sensors required for urban networks based on both standard and unique applications. This process must ensure that cost is minimized and should account for the complexity of terrain unique to every city.

(3) Users aren't aware of and therefore are not using emergency decision-making technologies and information that are available today. Outreach, education, and training mechanisms are needed.

(4) A delivery system is needed for layered GIS information to all public and commercial sectors. This may require a change in federal policy to authorize the communication of this information to these sectors.

(5) The process for defining how to design a network on an urban scale should address particular decision-making applications (e.g., define questions for applications and interact with users).

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Develop and implement test beds for urban areas.

(2) Explore the inclusion of road weather data for urban applications.

(3) Develop outreach, education, and training programs to meet the immediate needs of users.

(4) Develop a strategy for cost effective collection of data focusing on things that can be done now. Include the private sector role (including METADATA), products, and distribution

The **medium-long term action items/issues** (those which can be addressed in 4 years to 10 years) included:

(1) Ensure communications infrastructures are capable of accommodating the increasing amount of data and that formats are usable.

(2) Define a process on how to design a network on an urban scale and how to address particular decision-making applications.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum

Workshop 2B Summary

Workshop Name: Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues

Workshop Cochairs: (1) Dr. Robert Bornstein, San Jose State University and (2) Dr. John R. Scala, Millersville University

Rapporteurs: (1) Mr. Robert Dumont, DOC/NOAA/OFCM; and (2) Dr. Robert Katt, OFCM/STC

Guiding Questions

The questions posed below for the workshop were intended as guidance for focusing the workshop discussion.

(1) What visualization techniques are available or emerging that would help convey air/water quality and health hazard information to a variety of users?

(2) What new predictive initiatives address air quality forecasts and related health issues?

(3) What observational databases are needed for air/water quality modeling?

(4) What means are available to quantify and communicate air quality forecasts to decision makers?

(5) What evaluation and verification metrics are available or should be developed for air/water quality forecasts?

(6) What research tools can be used to measure socioeconomic impacts of wildfires and other regional severe atmospheric events on urban communities, as well as on the regional ecosystem?

Synopsis

Opening Remarks

The workshop cochairs welcomed the workshop participants and gave a general overview of the workshop's purpose which was to discuss and identify the research and development that is needed to support an ecosystem approach to health and other environmental issues in the urban community. Ideally, this approach should be part of an

integrated conceptual and strategic plan designed to minimize the effects of accidents, natural hazards, and terrorism-related events.

Group Discussion

The principal focus areas of the workshop were observations/instrumentation, data management, data assimilation and modeling, and the customer/user interface. Dr. Scala suggested three objectives which would address information gathering in the urban environment:

(1) We must acquire the necessary information in real time.

(2) We should utilize that information to address the customer's desire to know what may happen next.

(3) We must manage and analyze the information effectively so that we can determine the long-term impacts on the urban environment.

A wide-ranging discussion on "Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues" resulted in the following major findings with respect to observations/instrumentation, data management, data assimilation and modeling, and the customer/user interface:

(1) Observations/Instrumentation.

(a) Observations of the urban environment must be:

- Multi-scale networks with specific temporal and spatial resolution (e.g., fixed surface: mesoscale (centers at a few km), urban, neighborhood, roadway sensors, and observations updated every 15 minutes).
- Mobile: canyon-scale, few meters, real time.

(b) Instrumentation networks in the urban environment must be designed to address unique microclimates of the urban zone. Models (wind tunnel and numerical) should be designed to address specific fine-scale network attributes for a number of test cities.

(c) Assessment of the PBL is essential. Methods for assessing the PBL include LIDAR, radar, SODAR, and ceilometer.

(d) PBL assessment parameters should include: wind, temperature, PBL height (at least for test cities), surface and subsurface (ground/water) temperatures, precipitation, trace concentrations (gases and aerosols), vertical measurements with a resolution to 30 m, soil moisture, and fluxes (radiation, heat, momentum, and moisture).

(e) There are societal/community issues which must be considered, regarding network design and sensor placement to avoid, if possible, similar public response that developed during the proposed installation of the WSR-88D network.

(2) Data Management.

(a) Effective management of the data and information archive developed for the urban environment will be instrumental in addressing urban health and environmental issues. Key issues which the workshop participants identified included:

- The need for a national center to collect and manage the information. Perhaps the National Climatic Data Center (NCDC) could act as a repository.
- An interagency committee should be formed to oversee the design and management of the database system. It is essential that the database system be easily accessible. The system should be frequently updated; include "lots of metadata" accompanied by sufficient documentation (and be compatible with GIS); have standardized formats containing time, location, a naming convention; have XML as an option; and should consider the possibility of newer data methods. The database system should incorporate such concepts as data quality assurance/quality control vs. real-time data. The system should be open source and include societal data (e.g., demographic, economic, and diurnal/weekly patterns (?)) and ecological data. It should also incorporate a multi-source, multi-type data integration method.

(3) Data Assimilation and Modeling.

(a) To evaluate the environmental impacts on urban ecosystems, we must effectively assimilate the information gathered into the applicable modeling frameworks. The data assimilation issues discussed included the following:

- Assimilation of four-dimensional (4-D) lateral and upper boundary conditions are critical, and may be of more value than within urban measurements to initialize high resolution urban modeling efforts.
- Assimilation schemes to be considered include 3D-VAR, 4D-VAR, FDDA, NCAR methods, and FAA methods.
- The optimal interpolation scheme is old but cheap/fast. NCEP methods deserve consideration.
- There is a need to be able to assimilate remotely sensed surface, building, and aerosol data obtained on an irregular horizontal and vertical grid.

(b) Modeling considerations discussed included:

- Coupling of atmospheric transport and diffusion (ATD) model output with consequence models (e.g., health/safety impacts and others).
- Source location to support such activities as forensic modeling and contaminant identification (preferably by remote-sensing method).

- Model verification and certification based on user metrics (e.g., model performance under varying conditions and for varying averaging times and model post-processing and visualization to address end-user requirements).

(4) Customer/User Interface.

(a) In addressing urban health and environmental issues, it is critical that the customer/user be involved in the process. We need to identify the customer and:

- Find out what they want and how they intend to use the information provided.
- Use prototyping and develop products in an iterative manner.
- Educate users on the constraints (limitations) inherit in the products we provide them, and how to interpret the information to ensure appropriate application of the results.
- Communicate with users in a secure, reliable, robust, and fast manner.
- Develop effective product formats (graphical/text/tabular) and provide for multiple format delivery capability. That is, we need to tailor as needed for the emergency response center vs. customers in the field. Tailoring necessitates reliable communication practices. We also need multiple language capability.
- Ensure that data be displayed within the emergency management system so that it is not confusing to the user, thus emphasizing again the appropriate use by the customer.

(b) The bottom line is that users must have confidence in the results!

<u>Consensus Reached</u>

The workshop resulted in the following areas of general agreement:

(1) There is a need for improved multi-scale observations in the urban environment with an emphasis on the vertical observation of the PBL in greater detail.

(2) There is a need to establish a national database management center that facilitates data access and includes self-documenting metadata in standardized formats.

(3) There is a need to enable the integration of all data types and sources within an ecological framework (i.e., social, demographic, economic, etc.)

(4) There is a need to assimilate remotely sensed surface/building, boundary layer, and aerosol data into atmospheric transport and diffusion and other fine-scale models.

(5) There is a need to couple atmospheric transport and diffusion model outputs with consequence models, addressing health, safety, and other impacts.

(6) There is a need to develop model verification and validation procedures based on user metrics.

(7) The interface with users must be addressed in a more comprehensive and mutually supportive manner. It is necessary to find out what users want, how they want this information communicated, and how they operate. It is especially critical to get customer feedback during the product development/prototyping process. Greater outreach initiatives, end-to-end support, and identification of essential deliverables are needed.

Unresolved Issues

Issues that were articulated but could not be resolved during the panel session included:

(1) The optimal mix of instrument platforms and the temporal and spatial resolution of the required observations to foster a coordinated scientific design. The answer to the optimal mix question requires additional research, development, and testing.

(2) Urban test cities or test beds. The idea of these test sites needs to be further explored within the context of addressing urban health and environmental issues.

(3) Data management issues and the delivery of uncertainty information. These issues require extensive study.

Recommendation

Several key action items/issues were developed by the workshop participants.

The **short-term action item/issue** (those which can be addressed within the next year) included:

(1) The Office of the Federal Coordinator for Meteorological Services and Supporting Research should work within the Federal meteorological community and its coordinating infrastructure to establish an interagency committee on urban meteorology to address the consensus needs and unresolved issues identified during the course of this workshop and throughout the Forum.

The **medium-term action items/issues** (those which can be addressed within 4 years) included:

(1) Perform a study to determine the optimal mix of observations for the urban environment.

(2) Investigate the need for urban test cities or test beds (if we are to address the user needs of the urban environment).

(3) Address the issues of data management and the delivery of uncertainty information to the end user.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 3A Summary

Workshop Name: Communicating Hazardous Weather Risks in the Urban Environment

Workshop Cochairs: (1) Dr. David Krantz, Columbia University, (2) Ms. Sandy Thomson, WANE-TV, Fort Wayne, IN

Rapporteurs: (1) Mr. Frank Estis, OFCM/STC (2) Col Mark Weadon, DOD/USAF/Air Force Weather Deputy for Federal Programs (NOAA)

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What methods are needed to better communicate and disseminate meteorological information, particularly for impending hazards in the five focus areas?

(2) Where should research and development be focused to further improve the communication of risks in the five focus areas?

(3) What are examples of successful risk communication about hazards in the five focus areas that can be used as models? For example, can NOAA Weather Radio be expanded/modified to meet the needs of urban communities?

(4) What new or emerging technologies will help communicate risks in the five focus areas more effectively to the urban community?

(5) How can education, outreach, and training be more effective in eliciting rapid and appropriate public response to imminent hazards in the five focus areas?

Synopsis

Opening Remarks

Ms. Sandy Thomson opened the workshop by emphasizing that the workshop guiding questions and the attendees' inputs were the key components to a successful workshop. She also highlighted some key statistics from the Urban Meteorology handout book to illustrate why it is important to focus on this topic now.

Dr. David Krantz highlighted the fact that his research shows that it is easier to communicate probabilities of an event occurring when the event means something to the people that are expected to react to the event. The audience must understand what action

is required of them so they can decide if the probability of occurrence is important to them, versus the cost of action or no action.

Group Discussion

A wide-ranging discussion on "Communicating Hazardous Weather Risks in the Urban Environment" resulted in the following major findings:

(1) There is a need to make sure potential disaster information gets to the media, police, fire personnel, and all other First Responders quickly so it can be relayed to public.

(2) Any system to be used to communicate risk needs to be simple, clear, standard, and easy to relay to public.

(3) The elderly and other at-risk groups need to be targeted for support to ensure they receive disaster notification information.

(4) There is a need to identify the types of natural hazard information the public needs/wants, such as, incidence of hazard risks in the area of interest; text or graphic messages, types of communication media to be used, etc.

(5) The utility of maps is limited if users cannot locate their position relative to weather features. General lack of geographical literacy among the public must be considered when conveying risk via maps.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Standard ways and terminology to communicate risk are needed. We cannot have regional variations in the way weather risk is communicated to the public. A national standard is essential.

(2) To account for a transient society, research is needed to determine terms to use on a national basis to communicate risk.

(3) The public is very mobile. There needs to be some kind of GIS/GPS communication system to reach people even when in transit.

(4) One example of successfully using technology is the linking of on-air broadcast meteorology shows to more in-depth information on web sites. TV audiences can get more detailed and updated information continually via the web. But, all severe weather risk should be communicated completely through radio or television media, as many in the public do not have computers or NOAA Weather Radio.

(5) Some sort of "categorization" or "risk-possibility" scale needs to be developed for all severe weather areas, and should be the same "standard" for all weather events (i.e., color-coding, numerical scale, letter-coding, etc.), so that the public will always know the risk factor or degree of severity. This scale should be teamed with an action, (e.g., what to do or where to go for each category). Once this standardization or nationalization is decided, the general public needs to be educated.

(6) There is a greater need for management in all five focus areas (i.e., Severe Weather, Homeland Security, Air Quality, Water Quality, and Climate) to work together toward these goals, thereby avoiding confusion for the public.

Unresolved Issues

There were no issues articulated during the workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Research ways to reach elderly and other at risk groups, making sure to include social science involvement to identify stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.).

(2) Research terms to use to express risk to the public in a standard way, making sure to include social science involvement to identify stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.)

(3) Investigate using Homeland Security color code system for the weather warning system, and/or look at a numerical or alphabetical categorization that would be consistent with each event, and specifically, something common or already familiar to people (i.e., red means stop…take shelter; yellow means yield…exercise caution, etc.) A "scale" should help the public understand their risk factor and percentage probabilities of being affected by the event.

(4) Investigate some kind of GIS/GPS communication system to reach people even when in transit.

(5) Look into developing a matrix approach to communicating risk. Use probabilities to express degree of risk for each type of weather event and actions required at each level of probable occurrence.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Develop an education program to engage hotels and other tourist industry groups, as well as school systems in getting the word out to the public on potential disaster events.

(2) Develop an education program for K-12 students on a warning system and terms used so they will grow up alert to the potential threats. Work with educational systems on a national basis to make sure it is a standard national program.

(3) Develop an education program for broadcast meteorologists on how to present weather and its risks to the public using different media and make sure social science is involved under the auspices of the AMS certification program and the NWA seal certification program. Work with broadcasters and weather equipment vendors to help establish a common color coding for watch/warning maps, etc.

(4) Determine stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.)

(5) Seek NOAA's support to undertake a study on how to communicate weather risks (including uncertainty) to the general public. The study needs to include the expertise of sociologists and cognitive psychologists.

(6) Solicit user feedback on the clarity and comprehensibility of current modes of communicating weather risk.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 3B Summary

Workshop Name: Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, Atmospheric Transport and Dispersion, Space Weather, and Climate Applications

Workshop Co-Chairs: (1) CDR Stephanie Hamilton, DOD/USN/DTRA and (2) Dr. Steven Hanna, Harvard School of Public Health

Rapporteurs: (1) Dr. Robert Katt, OFCM/STC and (2) Mr. Jim McNitt, OFCM/STC

Guiding Questions

The following questions were presented to the workshop participants to help guide the discussion:

(1) What current or emerging science and technology resources are available to mitigate deficiencies in urban meteorological, atmospheric transport and dispersion and climate modeling? Are the funding resources for these existing efforts adequate?

(2) Are mechanisms available to transfer and apply emerging science and technology to address deficiencies in urban weather, atmospheric transport and dispersion, and climate modeling? If mechanisms are available, are they funded adequately to meet user requirements for modeling products?

(3) Are processes established to ensure the effective transfer of better modeling products to users' operations? What role should users play in the development and transfer process to ensure products are useful?

(4) What type of basic or applied research and development is needed to meet deficiencies or future needs/challenges in urban weather, ATD, and climate modeling?

(5) What criteria should be used to assign priorities for future research and development that addresses urban weather, atmospheric transport and dispersion, and climate modeling?

(6) How could collaborative research and development efforts be improved?

Synopsis

Opening Remarks

The purpose of the workshop was to discuss the research and development resources that are both available and required to address deficiencies in modeling for urban weather, atmospheric transport and dispersion, and climate applications. The co-chairs reviewed the guiding questions by providing several discussion topics for each question. The resulting discussion highlighted problems and in some cases, potential solutions, to the following problems/issues:

(1) Recent and current field studies and data bases.

(2) Test beds (long-term observing sites).

(3) Current modeling efforts and scientific problems.

(4) Data needs for model inputs and evaluations.

(5) Standards and guidelines for models and for data collection.

(6) R&D needs for urban weather, ATD and climate.

(7) Transfer from research to operations.

(8) Collaborations.

(9) Interface with users.

Group Discussion

A wide-ranging discussion on "Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, Atmospheric Transport and Dispersion, and Climate Applications" resulted in the following major findings:

(1) There is a need to collect, process, and synthesize data from existing field studies such as:

(a) Recent and current urban studies (e.g. Joint Urban 2003, NYC Urban Dispersion Program, DCNet).
(b) Fluid modeling (wind tunnels and water flumes).
(c) NSF urban climate and surface energy studies.

(2) There is a need to investigate urban data sets that are being developed by cities, government agencies, and others and add them to existing data bases being used to develop, calibrate, and evaluate urban models. Possibly additional parameters could be measured and procedures improved for their use as inputs to models.

(3) Data for fine-scale model development and evaluation, e.g., Computational Fluid Dynamics (CFD) model parameter calibration are needed. Involving a range of modelers and researchers when designing databases, for both current data analysis projects and for future data collection efforts is needed. The types of data needed include urban canopy/land cover/morphology, surface fluxes, soil moisture, ocean in coastal areas, water use, population, anthropogenic contributions, etc.

(4) Physical modeling facilities, such as wind tunnels are resources for urban modeling. They are important for improvements in knowledge of urban canopy atmospheric transport and dispersion.

(5) There is a need for establishing standards and guidelines for databases, model output, and model performance and acceptance criteria.

(6) Users' needs should be considered in prioritizing R&D needs.

(7) The transfer from research to operations should be user-based and include collaboration during all phases of the system life-cycle. Users should be included early and often. Involve social scientists and other related disciplines in the user interface. Recognize and account for differences in user communities.

(8) Collaborative studies are needed, but should include: leveraging of planned experiments, a clearinghouse for information, and better communications among user communities.

(9) For urban climate modeling, there is a need for a consistent way (e.g., test beds) to compare and evaluate model results.

(10) U.S. Weather Research Program (USWRP) Prospectus Development Team (PDT)-10 is a resource for modeling requirements in a wide range of topics that fall under urban meteorology, such as urban wildfires and enhancement to precipitation. USWRP PDT-11 is a resource for modeling requirements for air quality.

(11) For some needs such as first response to a CB release, a modeling capability is needed that allows immediate (i.e., within 1 or 2 minutes) response.

(12) Urban test beds need to be set up at all scales (street canyon to metropolitan), and should deal with interactions between urban areas and their surroundings.

(13) There is a need to foster collaborative work starting with federal agencies extending to strategic partnerships with local and state government agencies, the private sector, and universities.

Consensus Reached

The workshop presentations and the attendant discussion resulted in the following areas of general agreement:

(1) There is a need to collect, process, and synthesize data from existing field studies. New data sets for better understanding of urban meteorological and ATD processes and for model development are needed. There is a need for more continuous data records (urban meteorological and atmospheric transport and dispersion conditions over longer periods of time, such as test beds would provide).

(2) There is a need to investigate urban data sets which are being developed by cities, government agencies, and others. These data sets should be added to existing data bases being used to develop, calibrate, and evaluate urban models. Possibly additional parameters could be measured and procedures improved for their use as inputs to models.

(3) Collaboration and more effective communications are required in many of the ongoing urban R&D activities. Effective collaboration can lead to partnerships, leveraging of planned experiments, and better communication. Collaboration should include the integration of the end-users' feedback in every phase of a system's life-cycle. Social scientists should be involved to facilitate the interface between the developer, information provider, and end-users of the information (e.g., decision-makers and public). There is a need to foster collaborative work starting with federal agencies extending to strategic partnerships with local and state government agencies, the private sector, and universities.

(4) Urban test beds need to be set up at all scales (i.e., street canyon to metropolitan), and should deal with interactions between urban areas and their surroundings. Urban test beds should account for the effects of the ocean on the coastal urban areas. For urban climate modeling, the test bed can lead to a consistent way to compare and evaluate model results.

Unresolved Issues

Issues that were articulated but could not be resolved during the panel session included:

(1) The best way to assimilate meteorological observations in urban areas into high-resolution mesoscale meteorological models.

(2) Best approach to collect, process, and synthesize data from existing field studies.

(3) Best approach for test beds.

(4) Approach to implementing a national database for land cover/morphology data.

(5) How to establish standards and guidelines for databases, model output, and model performance and acceptance criteria. Standards Developing Organizations are preferred for some standards, such as for model performance (e.g., the ASTM currently has available a document describing standards for dispersion model evaluation).

(6) How to incorporate the multi-tiered modeling response required to provide increasingly sophisticated hazards predictions as more information about the source becomes available and more sophisticated meteorological inputs can be provided for use with the ATD code. Emergency responders at the workshop stated the need for a modeling capability that allows immediate (i.e., within 1 or 2 minutes) response.

(7) Approach for prioritizing research needs. How to set priorities. What are the prioritization factors?

(8) Basic research challenges. Basic research is required to improve surface fluxes, and to improve data assimilation methods.

(9) The urban meteorology community should be able to contribute to city planning, to address critical trade-offs and design issues (implications of vegetation on hydrology and water use).

(10) Future research is expected to involve more emphasis on sensor fusion, where observations of urban pollutant concentrations and meteorological variables are used to back-calculate the expected location and magnitude of the source (e.g., for CB releases by terrorists).

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Establish a science advisory group (representative of segments within the user community).

(2) List field and fluid modeling studies and experiments that have been done with points of contacts.

(3) Find out who is building urban databases.

(4) Identify user communities and facilitate communications among researchers and modelers, decision-makers, and the public.

(5) Improve mesoscale models and CFD models and establish links (e.g., two-way feedback) where possible.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Establish a clearinghouse (so that everyone can know what is available) for planned urban studies and data collection efforts.

(2) Start Federal interagency collaboration to plan a national, federated urban canopy/land cover/morphology database. Investigate work being done in the various Federal interagency working groups.

(3) Investigate existing urban meteorological, atmospheric transport and dispersion, and climate data sets and their applicability to current research.

(4) Develop urban parameterizations for mesoscale meteorological models and CFD models.

(5) Improve data assimilation and sensor fusion methods.

The **long-term action items/issues** (those which can be addressed in 4 – 10 years) included:

(1) Capture existing data needs and data synthesis required, such as the need to develop urban parameterizations for inputs to CFD and mesoscale models.

(2) Prioritize field and fluid modeling studies and experiments that should done, as well as longer-term test beds.

(3) Implement an accessible, distributed national data system for use in urban modeling

(4) Develop methods to integrate data in high-resolution models working at the micro-scale, including both current data and future data (point and volumetric). A range of modelers and researchers need to be involved to identify future data requirements.

(5) Improve research transfer to operations, emphasizing user-based needs.

(6) Plan field studies of urban parameters for use in fundamental models. These would include surface fluxes and turbulence profiles.

(7) Sustain urban test bed operations over a sufficient time to characterize model and instrument performance across the full range of weather variations.

(8) Further develop cross-discipline studies where urban meteorology is a component, such as urban design and planning, and risk-consequence studies.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.